Auditing the AUDIT: A systematic review of cut off scores for the Alcohol Use Disorders Identification Test (AUDIT) in low- and middle-Income countries

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Abstract

Key words

Alcohol Use Disorders Identification Test (AUDIT), Screening, Alcohol Use Disorders, Psychometrics, Low- and Middle-Income Countries, Review

Introduction

The Alcohol Use Disorders Identification Test (AUDIT) was developed by the World Health Organization (WHO) as a tool to screen for alcohol use disorders (AUD) in various populations[i]. The AUDIT is used to detect both AUD (harmful and dependent drinking) and at-risk alcohol consumption (hazardous drinking). This capability is one of its major advantages in comparison to other screening instruments, which generally focus only on harmful and dependent drinking [ii]. Since it was first published, the AUDIT has been translated into many different languages and also has been validated in different settings[iii]. Over the years the AUDIT has also been used extensively in clinical and epidemiological research across the world[iv].

The 10-item scale assesses three conceptual domains: alcohol intake (items 1–3), dependence (items 4–6), and adverse consequences (items 7–10). AUDIT is scored by summing the values associated with the various response options, and scores can range from 0 to 40. A range of cut off scores for the AUDIT have been proposed to identify AUD. The generally accepted cut off score of ≥8 provides good sensitivity to detect AUD, but a cut off score of ≥10 offers better specificity[v]. Furthermore, lower cut off scores have been recommended for special populations or for when the focus of the screening is on at-risk alcohol consumption[vi]. The WHO recommends the following scores for categorisation of AUD: hazardous drinking (8-15), harmful drinking (16-19), and dependent drinking (≥20[vii]).

Studies from high income countries (HICs) have recommended different ranges of cut off scores for their settings. A score of ≥13 was shown to be suitable for identifying alcohol dependence using the AUDIT in France[viii]. A cut off score of ≥5 was found to be most appropriate for identifying AUD in an outpatient population in Northern Germany[ix]. For the version of the AUDIT used in Korea (AUDIT-KR), cut off scores of ≥3 and ≥10 were recommended to identify hazardous drinking and AUD respectively[x]. In Australia the optimal cut off scores for harmful use and dependence were ≥10 and ≥17 respectively[xi]. The AUDIT has been translated into several languages such as Spanish, Slovak, Norwegian, French, German, Russian, Japanese, Swahili, Chinese, Czech, Vietnamese, Hindi, and Korean. However, only a few of these translations (Korean, Chinese, and Tibetan) have been adapted to take into account local variations in standard drink sizes or national recommendations regarding safe drinking levels[xii]. An example of such an adaptation is the US AUDIT, in which the first three questions have been adjusted for the standard U.S. drink size (14 grams), the number of response alternatives in questions 1 to 3 have been expanded, and the wording of question 3 has been modified [xiii].

There are a number of issues regarding the use of AUDIT which require further examination. The cultural views of AUD are influenced by prevailing norms in the society and hence there could be a cross-cultural difference in the threshold for the identification of disorders relating to the use of alcohol. A number of core concepts underpinning diagnosis of AUD have no equivalents in the local languages of various cultures, while other aspects lack cultural applicability because they do not reflect cultural and ethnic norms of drinking[xiv]. An example of the latter is item 10 of the AUDIT questionnaire, which asks about other people expressing concerned about one's drinking. In some cultures, comments on others' drinking behaviour are very common and are not considered an adequate indicator of pathological drinking behaviour[xv]. Furthermore, populations may also vary genetically, resulting in different alcohol tolerances and hence different trajectories to development of AUD[xvi].

Standardised instruments such as the AUDIT allow for comparison of findings across cultures and countries. However, standardised instruments that reflect a mainstream culture, when used in disparate cultural groups, also run the risk of measurement errors if the instruments lack cultural relevance. This issue raises several questions about the appropriateness in low- and middle- income countries (LMICs) of the cut off scores recommended by the WHO, especially considering that these scores are not appropriate even in some HICs. The aim of this review is to examine the use of non-WHO recommended AUDIT cut off scores used in LMICs, including the psychometric properties of these cut off scores. This review will shed light on the use of the

AUDIT in LMICs and will inform future efforts to examine its psychometric properties in various cultural settings to improve its use.

Methods

This systematic review was guided by an a priori defined protocol consistent with the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) statement[xvii] and registered on PROSPERO (CRD42016042757). The following electronic databases were searched: Cochrane library, Medline, EMBASE, PsycINFO, Global Health, Cumulative Index to Nursing and Allied Health Literature (CINAHL), Indmed (database of peer reviewed medical journals published from India), Literatura Latino Americana em Ciências da Saúde (LILACS- index of scientific and technical literature of Latin America and the Caribbean), and African Journals OnLine (AJOL- online library of peer-reviewed, African-published scholarly journals).

The search was conducted using appropriate search terms under the following concepts: AUDIT (e.g. AUDIT, AUDIT-C), alcohol use and alcohol use disorders (e.g. alcohol drinking, hazardous drinking), psychometrics and context of use (e.g. validity, reliability, screening), and LMICs (e.g. developing countries, names of all LMICs). The search strategy for Medline is presented in Appendix 1, and it was adapted to meet the unique requirements of the other databases.

NM conducted the search in June 2016, and NM and MI piloted the eligibility criteria and data extraction tool by applying them to the search returns. Subsequently, SK and AN independently assessed the titles and abstracts of the studies identified through the search of the electronic databases. If the title and abstract did not offer enough information to determine inclusion, the full paper was retrieved to ascertain whether it was eligible for inclusion. SK and AN then discussed their independent selections and arrived at a final list of eligible papers. AN inspected the reference lists of eligible papers and relevant reviews to include additional eligible papers that were not retrieved by the search of the electronic databases. AN also conducted a forward search on Web of Science using the eligible papers to identify studies which might have been missed in the original electronic database search and to identify eligible studies which cited any of the included papers. Finally, AG repeated the search in July 2018 to identify any studies that were published after the original search.

Eligibility criteria: There were no restrictions on year of publication, gender, and age of the participants. Only English language publications and studies conducted in LMICs were included. Randomised control trials (RCTs), observational studies, case reports, and case series were

included. Qualitative studies and any study which used a non-validated adaptation of the AUDIT questionnaire were excluded. Studies which used AUDIT cut off scores which were different from those recommended by the WHO, and/or tested the psychometrics of AUDIT cut off scores which were different from those recommended by the WHO were included.

Data extraction: Following PRISMA guidelines, a record was made of the number of papers retrieved, the number of papers excluded and the reasons for their exclusion, and the number of papers included. A data extraction form was designed for the papers, and guidelines were set to extract data relevant to the study aims. SC and SW independently extracted the data and any disagreements about extracted data were discussed and resolved. AN supervised the data extraction process.

Lastly, AG conducted a qualitative synthesis of the data.

Results

Fifty-seven studies (Table 1) were included in this review by using a multi-step process (Figure 1). Of these, most studies were conducted in Africa (n=21), followed by Asia (n=19) and South America (n=14); the remainder were conducted in Europe (n=2) and Mexico (n=1). India (n=12), Nigeria (n=9), and Brazil (n=10) produced most of the included studies.

Most studies were conducted in community settings (n=26), followed by tertiary care facilities (n=13). Communities included, but were not limited to, schools (e.g. Domingues, 2011; Strunin, 2013), urban areas (e.g. Ansoleaga, 2013; Chen, 2013), households (e.g. Kanyoni, 2015), slums (e.g. Ghosh, 2012), and villages (e.g. Jonas, 2014). Tertiary care facilities included, among others, infectious disease hospital units (Goar, 2011) and specialized HIV clinics (Farley, 2010; Luna, 2014; Parry, 2014). The rest were conducted in primary care (n=9) or secondary care (n=12) facilities such as primary health care clinics (Luitel, 2018) and outpatient clinics (Yee, 2015), respectively. Some studies combined settings, as in the case of one study which recruited participants from both the community (throughout St. Petersburg) and tertiary care facilities (i.e. addiction care sites; Lasser, 2018). The vast majority of studies were cross-sectional (n=49); the remainder were cohort studies (n=3) and randomised controlled trials (n=5).

Sample sizes in the studies ranged from 52 participants (Yee, 2015) to 12,781 (Ansoleaga, 2013). The median sample size was 337 participants. Most studies had samples of both men and women (n=39), but fourteen studies investigated only one gender: four with all-

female samples (Chen, 2013; May, 2018; Vythilingum, 2012; Nothling, 2013) and ten with all-male samples (Dasgupta, 2013; Endsley, 2017; Ghosh, 2012; Luford, 2013; Martins, 2012; Nadkarni, 2017*a* and *b*; Nayak, 2009; Pal, 2007; Patel, 2014). Four studies did not describe the gender distribution of their sample populations (Farley, 2010; Parry, 2014; Pinheiro, 2006; Guo, 2008).

The majority of the included studies did not measure psychometric properties of the AUDIT cut off scores that were used (n=43 studies, 75.4%). All of these non-validation studies used at least one cut off score that did not align with the WHO's recommendations, and these modified cut off scores were not tested for psychometric properties. However, many studies modified their specified cut off scores according to prior validation studies. For example, one study (Chen, 2013) used cut off scores of ≥8 to detect "probable drinking problems" and of ≥13 to detect "probable alcohol dependence." These scores were consistent with a prior validation study (Saunders, 1993). Similarly, a second study (Strunin, 2013) used cut off scores of ≥3 for high school students and ≥6 for university students to detect hazardous drinking, as per the recommendations of two prior studies (Díaz Martínez *et al.* 2008 and 2009). As demonstrated here, many studies—both those that did and did not use the WHO's recommended cut off scores—revised the WHO's terminology of the drinking states it was measuring such that it was impossible to verify if the scores were used consistently across studies (n=8, e.g. "alcohol use in excess of low risk"; Sau, 2017). Without psychometric validation and with inconsistent scoring and terminology, the AUDIT cut off scores that these 43 non-validation studies used could not be readily evaluated.

Of the 57 studies, 14 were validation studies (Table 2). These 14 studies used a wide range of AUDIT cut off scores to detect different levels of drinking. Cut off scores to detect hazardous drinking ranged from ≥3 to ≥5, for harmful drinking from ≥5 to ≥16, and for dependent drinking from ≥7 to ≥24. Nearly all of these studies used at least one cut off score lower than those recommended by the WHO (n=12). Additionally, about one-third of these validation studies recommended different cut off scores based on gender (n=4). Many of these validation studies, much like the non-validation studies, replaced the WHO's terminology regarding levels of drinking (hazardous, harmful, and dependent) with other terminology (e.g. "alcohol abuse," "alcohol use disorder," "potential alcohol abuse," and "binge drinking"). This non-standard terminology precluded subsequent synthesis of these results.

Of the remaining 11 studies which included both psychometric data and standard terminology, no cut off scores clearly outperformed the rest. For hazardous drinking, all of the included cut off scores (≥3 to ≥5 yielded psychometric results which ranged from 91.5% to 96.2% for sensitivity, from 63.3% to 91.5% for specificity, from 58.1% to 89.3% for Positive Predictive Value (PPV), and from 94.8% to 96.9% for Negative Predictive Value (NPV). For harmful drinking, a cut off score of ≥7 or ≥8 in two studies (Adewuya, 2005 and Tsai, 2005, respectively) displayed better psychometric properties (90.0% sensitivity, 86.2% specificity, 47.4% PPV, 98.4% NPV in Adewuya, 2005; 96% sensitivity, 85% specificity, 85% PPV, 96% NPV in Tsai, 2005) than a lower cut off score of ≥5 (75% sensitivity, 64.5% specificity, 45% PPV, 87% NPV; Santis, 2009). One study found that an even higher score of ≥16 for harmful drinking yielded the highest psychometric results within the study (85.3% sensitivity, 89.4% specificity; Pal, 2004). Dependent drinking was measured with the widest range of cut off scores (≥7 to ≥24), and all but a cut off score of ≥7 (with sensitivity 63.6%, specificity 75%, PPV 46.7%, NPV 85.7%; Santis, 2009) yielded high psychometric properties (sensitivity ranged from 77 to 100%, specificity from 63 to 97%, PPV from 20 to 91%, and NPV from 83.9 to 100%). Overall, a wide range of AUDIT cut off scores performed well across studies. For more details on the psychometric properties associated with different AUDIT cut off scores, please refer to Table 3.

Discussion

Key Findings

This review aimed to examine the ways in which the AUDIT has been used in LMICs. More specifically, it aimed to study the cut off scores that have been used to detect AUD in LMICs. Our search yielded 57 relevant results with heterogenous study designs, samples, and contexts.

One major finding was the lack of psychometric data on the AUDIT cut off scores used in most of the studies. Even though many of these studies cited past studies which validated these cut off scores, they rarely cited studies that took place in the same socioeconomic and cultural contexts. For example, a study of female sex workers in Guangxi, China (Chen, 2013) cited a validation study that took place across many countries (Australia, Bulgaria, Kenya, Mexico, Norway, and the US), but did not include China or even other Asian countries[xviii]. The geographical and cultural diversity of these settings renders this comparison weak, as prior research has suggested that the same cut off scores on the AUDIT do not function equally well across cultures or populations[xixxx]. Therefore these cut off scores, even when previously

validated in prior studies, could not be properly evaluated for their applicability and validity in the studies at hand.

One major barrier to synthesising the data about AUDIT cut off scores was the diversity of terminology used to describe different categories of AUD. This inconsistent terminology, something that has historically plagued AUD research, was common across studies, regardless of whether or not these studies measured psychometrics. Although the WHO recommends cut off scores that will detect hazardous, harmful, and dependent drinking, many research studies have replaced these terms with terms such as “low risk” use or “binge drinking”. Without the use of standard terminology, it is impossible to determine whether the AUDIT cut off scores are measuring the same constructs across studies, thereby limiting their cross-comparability.

Our most critical finding is that nearly all the AUDIT cut off scores reported in these validation studies were lower than those recommended by the WHO. This finding suggests that the original recommendations maximized specificity at the price of sensitivity, and that dropping these cut off scores further will tend to yield higher psychometric results and will identify more people at risk of AUD. Only ten studies included in our review used the WHO’s standardized terminology and collected psychometric data about AUDIT cut off scores. There was a range of cut off scores with high (>70% across measures) psychometric properties across these ten studies, and that is most likely a product of the different cultural contexts in which these studies took place. Past research has suggested that the AUDIT must be culturally adapted because of the varying definitions across cultures of standard drinks, hazardous or heavy drinking, and so on[xxi]. One reason for this could be that a tool like the AUDIT cannot be assumed to work in the same way across cultures, given that substance use varies due to varying social expectations and prevailing laws[xxii]. For example, one study included in this review (May, 2018) identifies binge drinking on Friday and Saturday nights among women of childbearing age as a drinking pattern common in South Africa, but not necessarily universally. Screening tools might not function in a similar manner given varying drinking patterns[xxiii]. Another example of contextual differences in the constructs around alcohol use is the definition of a standard drink. For example, 8 grams of pure ethanol in the United Kingdom is a standard drink, while it is 14 grams in the United States. These varying definitions likely contribute to the diversity of cut off scores with good psychometric properties. The WHO AUDIT handbook itself recommends that the tool’s cut off scores be adjusted according to “national or cultural standards,” albeit without further exploring these standards[xxiv] or recommending processes for making the adjustments. Furthermore, this recommendation is not particularly helpful in countries which do not have

standard drink measurements or indeed have well established cultural norms around drinking behaviours. Thus our finding that different cut off scores work well in different cultural contexts is consistent with past literature on the AUDIT.

Finally, several studies included in this review (n=10) used different AUDIT cut off scores based on gender. Although WHO recommendations do not explicitly encourage gender-based cut off scores, addictions literature emphasizes the importance of making these distinctions when using the AUDIT[xxvxxvi]. Much as drinking patterns vary across cultures, so too can drinking patterns and their impact vary across genders[xxvii]. Thus future studies should continue to examine differences in psychometrics of the AUDIT based on gender. Existing studies which study psychometrics but without mixed samples (e.g. Endsley, 2017; Nayak, 2009) should be interpreted carefully, as cut off scores which yield robust psychometric data in samples of only men may not be generalizable to women and vice versa.

Strengths and Limitations

Our review was limited by our inclusion criteria. We excluded non-English-language studies and grey literature, which could mean that we did not cover all relevant data. The former limitation may be particularly significant considering that our review focuses on LMICs, which likely produce research in non-English languages.

Our review's major strength lies in its originality: to date, no systematic review has been conducted to comprehensively investigate the way in which the AUDIT has been used and adapted in LMICs. Although such studies exist in high-income countries[xxviiixxix], these findings cannot be generalized to the LMIC context. LMICs encounter a different set of health-related problems and a dearth of health-related resources with which to tackle these problems. Thus reviews such as this one, which focus exclusively on LMICs, are imperative in supporting contextually informed research.

Implications

Our review underscores the large gap in psychometric data regarding AUDIT cut off scores in LMICs. It highlights the clear need for more rigorous testing of the AUDIT tool across cultural contexts and in mixed-gender samples, given how sensitive the tool is to demographic differences. Thus the AUDIT must be adapted and validated every time it is used in a new context that is not comparable to any previous applications of the tool. These cultural adaptations of the tool are hugely important because without them, alcohol-related issues could

be under-reported or mis-reported in LMICs—where these issues are becoming increasingly common and debilitating[xxx]. It is only with rigorously validated screening measures that we can develop a fuller picture of the nature of alcohol-related problems in LMICs, and begin to help those suffering from these problems. Furthermore, the AUDIT must be evaluated separately by gender and age (e.g. adolescents, elderly), as these will most likely affect the psychometric properties of the tool.

Conclusions

Our review has highlighted the large gap in research regarding the psychometrics and application of the AUDIT in LMICs. This gap points us to two vital next steps: first, more research must be conducted in LMICs to test the psychometrics of AUDIT cut off scores in different cultural contexts, as the wide range of results found in this study suggest that the recommended AUDIT cut off scores are not universally generalizable. Second, standard terminology must be used to describe different levels of drinking (i.e. the WHO's suggestions of hazardous, harmful, and dependent) such that psychometric studies can be more readily compared.

Fig 1: Flow diagram of process leading to selection of papers for the review

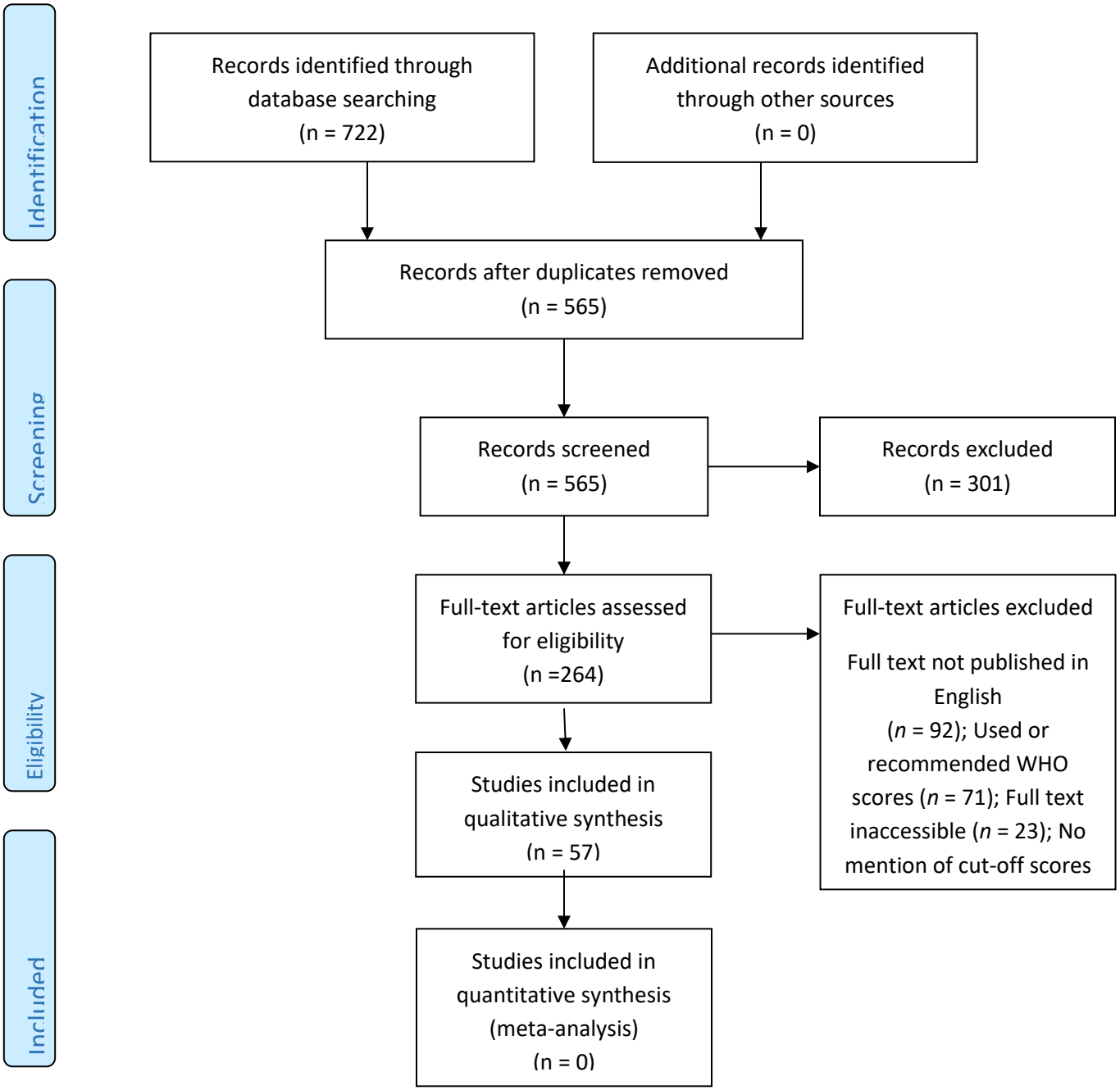

Table 1: Studies included in the systematic review

Author (Year)	Country	N	Sample	Setting	Study design
Abayomi (2013)	Nigeria	443	Male (M) 291 (65.7%); Female (F) 152; Mean age (A) 21 (Range 14-28) years	Community (University)	Cross-sectional
Adams (2012)	South Africa	143	M 70 (49.0%); F 73; A 21.6 (18-25) years	Community	Cross-sectional
Adewuya (2005)	Nigeria	248	M 181 (73.0%); F 67; A 22.5 years	Community (University)	Cross-sectional
Ansoleaga (2013)	Chile	12781	M 5653 (44.4%); F 7128; A 18–25 (15.9%), 26–34 (20.5%), 35–44 (25.1%), 45–54 (21.3%), 55–65 (17.2%)	Community	Cross-sectional
Blair (2017)	Uganda	1720	M 756 (44.1%); F 957; age range 13-52, median age 27	Community	Cohort
Brisibe (2011)	Nigeria	322	M 166 (51.6%); F 156; A 41.4	Community	Cross-sectional
Chen (2013)	China	983	Urban female sex workers; A 24.42	Community	Cross-sectional
Chishinga (2011)	Zambia	649	Patients attending Tuberculosis (TB) or Anti Retroviral Treatment (ART) clinic; M 363 (55.9%); F 286; median age 33 years	Primary care	Cross-sectional
Dasgupta (2013)	India	105	M 105 (100%); A 30-39 years (85.7%)	Community	Cross-sectional
D'Costa (2007)	India	1567	Private general practice attendees; M 338 (41%); F 597	Primary care	Cross-sectional
Domingues (2011)	Brazil	398	Medical students; M 174 (43.7%); F 224; A 20.7 years	Community	Cross-sectional

Endsley (2017)	India	600	Adult males, A 32.7	Community	Cross-sectional
Farley (2010)	Nigeria	399	HIV-infected adults in a HIV care program	Tertiary care	Cross-sectional
Ghosh (2012)	India	228	Males living in slums; A 31.4 years	Community	Cross-sectional
Goar (2011)	Nigeria	160	Patients being treated for HIV/AIDS at an infectious disease unit of hospital in a major city; M 57 (35.6%); F 103; A 35.6 years	Tertiary care	Cross-sectional
Guo (2008)	China	3171	A 43.8 years	Community	Cross-sectional
Herrera (2015)	Peru	399	MSM and transgender women in sexually transmitted infection (STI) clinics; M 310 (77.7%); F 89; median age 30 years	Secondary care	Cross-sectional
Issa (2012)	Nigeria	241	Doctors at a teaching hospital; M 182 (75.5%); F 59	Tertiary care	Cross-sectional
Jonas (2014)	India	4711	Villagers in rural area; M 2191 (46.5%); F 2520; A 49.5 (30–95) years	Community	Cross-sectional
Kanyoni (2015)	Rwanda	2479	Youth (14-35 years); M 1388 (56.0%); F 1091; A 23.2 years	Community	Cross-sectional
Lasser (2018)	Russia	351	M 219 (70.9%); F 132; A 33.5 years	Community and tertiary care	Cross-sectional
Ludford (2013)	Peru	5148	Sexually active men who have sex with men (MSM); A 29.5 years	Community	Cross-sectional
Luitel (2017)	Nepal	1983	M 703 (39.9%); F 1280; A 39.8 years	Community	Cross-sectional
Luitel (2018)	Nepal	1474	M 504 (34.2%); F 970; A 39.4 years	Primary care	Cross-sectional

Luna (2014)	Brazil	200	HIV-infected patients in a specialized clinic for HIV care; M 133 (66.5%); F (67); A 37.4 years	Tertiary care	Cross-sectional
Machado (2014)	Brazil	82	Hepatitis C-infected patients in outpatient clinic for viral hepatitis, M 52 (63.4%); F 30; A 45.1 years	Secondary care	Cross-sectional
Malbergier (2015)	Brazil	438	HIV-positive patients on ART in a HIV treatment center; M 236(52%); F 213; A 41.38 years	Secondary care	Cross-sectional
Martins (2012)	Brazil	123	Male patients with liver disease in a liver disease outpatient unit; A 42.64 years	Secondary care	Cross-sectional
May (2018)	S Africa	193	Pregnant women	Primary care	Cross-sectional
Menezes-Gaya (2010a, 2010b)	Brazil	530	Patients from a 'Psychosocial Care Center for Alcohol and Drugs (PCC-AD)' and emergency department; M 351(66%); F 179; A 36 years	Tertiary care	Cross-sectional
Morilha (2014)	Brazil	146	Patients with acute coronary syndrome (ACS) admitted to the hospital; M 95 (65.1%); F 51	Tertiary care	Cohort
Nadkarni (2017a, 2017b)	India	377	Adult males (18-65 years), A 42 years	Primary care	RCT
Nakhli (2011)	Tunisia	266	University students; M 152 (57.1%); F 114; A 21.2 years	Community	Longitudinal
Nayak (2009)	India	1043	Urban and rural males	Community	Cross-sectional
Ndetei (2009)	Kenya	2770	Patients admitted in general medical facilities; M 1186 (42.8%); F 1584; age range 18 - 90 years	Primary, secondary and tertiary care	Cross-sectional

Nothling (2013)	South Africa	70	70 mother-child dyads infected with HIV; A 28.8 (range 16–64) years	Primary care	Cohort
Obadeji (2015)	Nigeria	122	Doctors at a teaching hospital; M 97 (79.5%); F 25; A 35.65 years	Tertiary care	Cross-sectional
Olisah (2009)	Nigeria	120	Patients with HIV/AIDS attending an outpatient virology clinic; M 78 (65%); F 42; A 32.4 years	Secondary care	Cross-sectional
Pal (2004)	India	297	Patients at either a de-addiction center or a community outreach clinic who had used alcohol in the past year, M 294 (99%); F 3; A 38.1 years	Secondary and tertiary care	Cross-sectional
Pal (2007)	India	90	Males with problematic alcohol use; A 29.7 years	Community	Randomised controlled trial (RCT)
Parry (2014)	South Africa	260	HIV positive patients on ART in ART clinics; hazardous/harmful drinkers	Tertiary care	RCT
Patel (2014)	India	400 (estimated)	Primary Health Centre (PHC) attendees with depression or alcohol use disorder; AUDIT used on only males	Primary care	RCT
Pinheiro (2006)	Brazil	386 couples	Couples living in an urban area; A 30.3 years	Community	Cross-sectional
Pradhan (2012)	Nepal	1068	Patients attending outpatient department of a university hospital; M 587 (55%); F 481; A 47.9 years in males and 47.5 years in females	Secondary care	Cross-sectional
Santis (2009)	Chile	95	Adolescent students attending public school; M 53 (55.8%); F 42; A 15.9 years	Community	Cross-sectional

Sau (2017)	India	99	M 54 (54.5%); F 45; A 38.62 years	Community	Cross-sectional
Sekulic (2012)	Bosnia and Herzegovina	1032	M 435 (42.2%); F 597	Community	Cross-sectional
Simbayi (2004)	South Africa	257	Patients receiving services at STI clinic; M 149 (58.0%); F 78; A 27.5 years	Secondary care	Cross-sectional
Simbayi (2006)	South Africa	226	Patients receiving services at STI clinic; M 134 (59.3%); F 92; Median age 26 years	Secondary care	Cross-sectional
Strunin (2013)	Mexico	27,046 (high school) 22,417 (university)	Public high school and university students; M 24,237 (49%); F 25,226; In high school 67.5% were age 15 and in university 56% were 18 years old	Community	Cross-sectional
Tsai (2005)	China	112	Inpatients from gastro-enterology wards at a medical research center; M 78 (69.9%); F 34; A 49.9 years	Tertiary care	Cross-sectional
Vythilingum (2012)	South Africa	323	Adult women presenting to their first antenatal visit at midwife obstetric units; A 24.6 years	Tertiary care	Cross-sectional
Yee (2015)	Malaysia	52	Psychiatric patients who consume alcohol, at psychiatric outpatient clinics; M 51 (98.1%); F 1; A= 40.1 years	Secondary care	Cross-sectional
Zucoloto (2013)	Brazil	284	Undergraduate students; M 83 (29.2%); F 201; A 21.18	Community	Cross-sectional

Table 2: Studies that did not examine the psychometric properties of AUDIT cut off scores used (non-validation studies)

Author (Year)	Cut off score(s) used or recommended
Adams (2012)	≥8 (harmful or hazardous use) ≥13 in women, ≥15 in men (alcohol dependence)
Ansoleaga (2013)	≥6 (hazardous use)
Blair (2017)	>3 (hazardous use)
Brisibe (2011)	≥8 (abuse/harmful use) ≥20 (alcohol dependence)
Chen (2013)	≥8 (probable drinking problem) ≥13 (probable alcohol dependence) 0-7 (low risk drinking) 8-15 (risk drinking) 16-19 (heavy drinking) 20-40 (hazardous drinking)
Dasgupta (2013)	≥8 (hazardous and harmful use) ≥12 (alcohol dependence)
D'Costa (2007)	≥8 (harmful use or dependent drinking)
Domingues (2011)	<8 (not diagnosable alcohol problem) 8 to 11 (concerning consumption of alcohol) 12-15 (serious indication of a drinking problem) >15 (drinking problem)
Farley (2010)	≥8 or ≥10 (hazardous use)

Ghosh (2012)	≥8 (hazardous or harmful use) ≥13 (alcohol dependence)
Goar (2011)	4-7 (harmful use) ≥8 (hazardous use [alcohol abuse])
Herrera (2015)	≥17 (severe alcohol use disorder)
Issa (2012)	0–4 (moderate alcohol use) ≥5 (hazardous use)
Jonas (2014)	≥8 (hazardous use) Women: ≥13 (alcohol dependence) Men: ≥15 (alcohol dependence)
Kanyoni (2015)	8-15 (medium level of alcohol dependence) ≥16 (high level of alcohol dependence)
Lasser (2018)	Women: ≥13 (alcohol dependence) Men: ≥15 (alcohol dependence)
Ludford (2013)	≥20 (alcohol dependence) 17-19 (harmful use) 8-16 (hazardous use)
Luitel (2017)	>9 (alcohol abuse or alcohol dependence)
Luitel (2018)	>9 (alcohol abuse or alcohol dependence)
Luna (2014)	≥8 (harmful or hazardous drinking) Women: ≥13 (alcohol dependence) Men: ≥15 (alcohol dependence)
Machado (2014)	≥8 (harmful use) 8-15 (mild cases) ≥16 9 (severe cases--high risk consumption)

Malbergier (2015)	≥8 (harmful use)
Martins (2012)	8-15 (average-risk user) ≥16 (high-risk user or with likely diagnosis of mental disorder related to the use of alcohol)
May (2018)	>4 (current alcohol use at the light to moderate range and above) ≥8 (problem or heavy drinking)
Morilha (2014)	≤7 (low-risk drinking) ≥8 (high-risk alcohol abuse) 1-7 (hazardous use) 8-19 (harmful use) >20 (alcohol dependence)
Nadkarni (2017a, 2017b)	12-19 (harmful use)
Nakhli (2011)	>13 (alcohol dependence)
Ndetei (2009)	4-12 (normal) 13-18 (harmful use) ≥19 (alcohol dependence)
Nothling (2013)	≥8 (alcohol abuse) ≥13 (alcohol dependence)
Obadeji (2015)	0-4 (moderate use) ≥5 (hazardous use)
Olisah (2009)	5 to 6 (hazardous use) 7 to 8 (alcohol abuse) ≥9 (alcohol dependence)
Pal (2007)	8 or 9 (hazardous use)

	≥10 (alcohol dependence)
Parry (2014)	Men: Six or more drinks on one occasion at least weekly, and score no more than 22 on the AUDIT (harmful/hazardous use) Women: Four or more drinks on one occasion at least weekly, and score no more than 22 on the AUDIT (harmful/hazardous use)
Patel (2014)	12-19 (harmful use)
Pinheiro (2006)	≥10 (alcohol related disorder/alcohol misuse)
Sau (2017)	≥8 (alcohol use in excess of low risk) ≥16 (harmful and hazardous use) ≥20 (alcohol dependence)
Sekulic (2012)	≥11 (harmful drinking) ≤10 (non-harmful drinking)
Simbayi (2004)	≥9 (may be at risk or who are experiencing alcohol problems) ≥13 (likely alcohol use problems)
Simbayi (2006)	≥9 (possible risk for alcohol problems) ≥13 (probable alcohol use problems)
Strunin (2013)	≥3 (hazardous or harmful use) for high school students ≥6 (hazardous or harmful use) for university students
Vythilingum (2012)	>6 (risky drinking) >20 (alcohol dependence)
Yee (2015)	≥5 (potential alcohol abuse)

Table 3: AUDIT validation studies

Author (Year)	Country	Cut off score(s) used or recommended	Sensitivity	Specificity	Positive Predictive Value (PPV)	Negative Predictive Value (NPV)
Abayomi (2013)	Nigeria	≥5 (hazardous use)	93.5%	91.5%		
Adewuya (2005)	Nigeria	≥5 (hazardous use)	93.5%	91.5%	89.3%	94.8%
		≥7 (harmful use)	90.0%	86.2%	47.4%	98.4%
		≥9 (alcohol dependence)	100.0%	94.1%	20.0%	100.0%
Pal (2004)	India	≥8 (harmful use)	93.9%	66.7%		
		≥16 (harmful use)	85.3%	89.4%		
		≥8 (alcohol dependence)	96.2%	28.6%		
		≥10 (alcohol dependence)	95.2%	42.9%		

		≥24 (alcohol dependence)	81.0%	85.7%		
Pradhan (2012)	Nepal	Women: ≥4 (hazardous use) Men: ≥5 (hazardous use) ≥9 (alcohol dependence or abuse) Men: Women: ≥11 (alcohol dependence) Men:	91.5% 93.7% 96.7% 94.3% 92.7%	91.7% 91.4% 84.4%	90.3% 80.1% 76.3%	97.2% 97.8% 95.5%

		Women:	89.4%	90.5%	72.1%	96.9%
Chishinga (2011)	Zambia	Men: ≥20 (alcohol use disorder) Women: ≥24 (alcohol use disorder)	55% 60%		50% 60%	
Endsley (2017)	India	≥6 (alcohol abuse) ≥13 (alcohol dependence)	87% 77%	63% 91%		
Guo (2008)	China	≥10 (alcohol abuse/dependence) ≥13 (alcohol dependence)	87.7% 85.7%	88.1% 84.6%	91% 75%	83.9% 91.7%
Menezes-Gaya (2010a, 2010b)	Brazil	≥9 (alcohol abuse) Women: ≥12	88%	87%	81%	91%

		(alcohol dependence) Men: ≥13 (alcohol dependence)	82% 90%	97% 92%	87% 88%	99% 94%
Nayak (2009)	India	≥9 (any alcohol use disorder) (alcohol dependence) ≥10 (any alcohol use disorder) (alcohol dependence)	81.15% 81.82% 77.87% 79.55%	80.03% 76.60% 82.45% 79.25%	43.39% 32.43% 46.57% 34.48%	95.58% 96.84% 94.99% 96.58%

Santis (2009)	Chile	≥3 (hazardous use) ≥5 (harmful use) ≥7 (alcohol dependence)	96.2% 75% 63.6%	63.3% 64.5% 75%	58.1% 45% 46.7%	96.9% 87% 85.7%
Tsai (2005)	China	≥8 (harmful use) ≥11 (alcohol dependence)	96% 94%	85% 63%	85% 31%	96% 98%
Zucoloto (2013)	Brazil	Women: >3 (binge drinking) Men: >5 (binge drinking)	90.74% 90.74%	73.68% 75.0%		

Appendix 1: Search strategy for Medline

1. AUDIT.tw
2. AUDIT-C.tw
3. AUDIT-3.tw
4. AUDIT-4.tw
5. Alcohol Use Disorders Identification Test.tw
6. **OR (1-5)**

7. Alcohol$.tw
8. Drink$.tw
9. Dependent Drink$.tw
10. Problem Drink$.tw
11. Heavy Drink$.tw
12. Hazardous Drink$.tw
13. Harmful Drink$.tw
14. Binge Drink$.tw
15. Heavy Episodic Drink$.tw
16. Unhealthy drink$.tw
17. Addictive Drink$.tw
18. Abusive Drink$.tw
19. Excessive Drink$.tw
20. Disinhibited Drink$.tw
21. Uncontrolled Drink$.tw
22. Risky Drink$
23. Drunk$.tw
24. Consumption.tw
25. OR (7-24)
26. Alcoholism/
27. Alcohol Drinking/
28. Alcohol Abstinence/
29. Alcohol-Related Disorders/
30. Alcoholic Intoxication/

31. Ethanol/
32. OR (26-31)
33. OR (25, 32)

34. Validity.tw
35. Reliability.tw
36. Psychometric$.tw
37. Characteristics.tw
38. Cut-off.tw
39. Cut off score.tw
40. Cut off point.tw
41. Threshold.tw
42. Reproducibility of Results.tw
43. Screening.tw
44. Mass Screening.tw
45. Assessment.tw
46. Risk Assessment.tw
47. Sensitivity.tw
48. Specificity.tw
49. Surveys
50. Questionnaires.tw
51. OR (34-50)
52. Reproducibility of Results/
53. Mass Screening/
54. Psychometrics/
55. Risk Assessment/
56. Sensitivity and Specificity/
57. Surveys and Questionnaires/
58. OR (52-57)
59. OR (51,58)

60. Developing.tw

61. Less$ developed.tw
62. Under developed.tw
63. Underdeveloped.tw
64. middle income.tw
65. low$ income.tw
66. Lmic$.tw
67. Lamic$.tw
68. Transitional.tw
69. Third world.tw
70. OR (60-69)
71. countr$.tw
72. nation$.tw
73. population$.tw
74. world.tw
75. Or (71-74)
76. AND (70, 75)
77. Afghanistan.tw
78. Albania.tw
79. Algeria.tw
80. Angola.tw
81. Armenia$.tw
82. Azerbaijan.tw
83. Bangladesh.tw
84. Benin.tw
85. Byelarus$.tw
86. Belarus.tw
87. Belorussian.tw
88. Belorussia.tw
89. Belize.tw
90. Bhutan.tw
91. Bolivia.tw
92. Bosnia.tw
93. Herzegovina.tw
94. Hercegovina.tw

95. Botswana.tw
96. Brazil.tw
97. Bulgaria.tw
98. Burkina Faso.tw
99. Burkina Fasso.tw
100. Upper Volta.tw
101. Burundi.tw
102. Urundi.tw
103. Cambodia.tw
104. Khmer Republic.tw
105. Kampuchea.tw
106. Cameroon$.tw
107. Cameron$.tw
108. Cape Verde.tw
109. Cabo Verde.tw
110. Central African Republic.tw
111. Chad.tw
112. China.tw
113. Colombia.tw
114. Comoros.tw
115. Comoro Islands.tw
116. Comores.tw
117. Mayotte.tw
118. Congo.tw
119. Zaire.tw
120. Costa Rica.tw
121. Cote d Ivoire.tw
122. Ivory Coast.tw
123. Cuba.tw
124. Czechoslovakia.tw
125. Slovak$.tw
126. Djibouti.tw
127. French Somaliland.tw
128. Dominica$.tw

129. East Timor.tw
130. East Timur.tw
131. Timor Leste.tw
132. Ecuador.tw
133. Egypt.tw
134. El Salvador.tw
135. Eritrea.tw
136. Ethiopia.tw
137. Fiji.tw
138. Gabon$.tw
139. Gambia.tw
140. Gaza.tw
141. Georgia$ Republic.tw
142. Ghana.tw
143. Gold Coast.tw
144. Grenada.tw
145. Guatemala.tw
146. Guinea.tw
147. Guiana.tw
148. Guyana.tw
149. Haiti.tw
150. Honduras.tw
151. India.tw
152. Indonesia.tw
153. Iran.tw
154. Iraq.tw
155. Jamaica.tw
156. Jordan.tw
157. Kazakh$.tw
158. Kenya.tw
159. Kiribati.tw
160. Korea.tw
161. Kosovo.tw
162. Kyrgyz$.tw

163. Kirghiz$.tw
164. Kirgizstan.tw
165. Lao PDR.tw
166. Laos.tw
167. Lebanon.tw
168. Lesotho.tw
169. Basutoland.tw
170. Liberia.tw
171. Libya.tw
172. Macedonia.tw
173. Madagasca$.tw
174. Malagasy.tw
175. Malay$.tw
176. Sabah.tw
177. Sarawak.tw
178. Malawi.tw
179. Maldives.tw
180. Nyasaland.tw
181. Mali.tw
182. Marshall Islands.tw
183. Mauritania.tw
184. Mauritius.tw
185. Agalega Islands.tw
186. Mexico.tw
187. Micronesia.tw
188. Middle East.tw
189. Moldov$.tw
190. Mongolia.tw
191. Montenegro.tw
192. Morocco.tw
193. Ifni.tw
194. Mozambique.tw
195. Myanma$.tw
196. Burma.tw

197. Namibia.tw
198. Nepal.tw
199. Antilles.tw
200. Nicaragua.tw
201. Niger$.tw
202. Pakistan.tw
203. Palau.tw
204. Palestine.tw
205. Panama.tw
206. Papua New Guinea.tw
207. Paraguay.tw
208. Peru.tw
209. Philippines.tw
210. Philipines.tw
211. Phillipines.tw
212. Phillippines.tw
213. Romania.tw
214. Rumania.tw
215. Roumania.tw
216. Rwanda.tw
217. Ruanda.tw
218. Saint Lucia.tw
219. St Lucia.tw
220. Saint Vincent.tw
221. St Vincent.tw
222. Grenadines.tw
223. Samoa$.tw
224. Islands or Navigator Island.tw
225. Navigator Islands.tw
226. Sao Tome.tw
227. Senegal.tw
228. Serbia.tw
229. Sierra Leone.tw
230. Sri Lanka.tw

231. Ceylon.tw
232. Solomon Islands.tw
233. Somali$.tw
234. South Africa$.tw
235. Sudan.tw
236. Surinam$.tw
237. Swaziland.tw
238. Syria$.tw
239. Tajikistan.tw
240. Tadzhikistan.tw
241. Tadjikistan.tw
242. Tadzhik.tw
243. Tanzania.tw
244. Thailand.tw
245. Togo$.tw
246. Tonga.tw
247. Tunisia.tw
248. Turkey.tw
249. Turkmen$.tw
250. Tuvalu.tw
251. Uganda.tw
252. Ukraine.tw
253. USSR.tw
254. Soviet Union.tw
255. Union of Soviet Socialist Republics.tw
256. Uzbek$.tw
257. Vanuatu.tw
258. New Hebrides.tw
259. Vietnam.tw
260. Viet Nam.tw
261. West Bank.tw
262. Yemen.tw
263. Yugoslavia.tw
264. Zambia.tw

265. Zimbabwe.tw
266. Rhodesia.tw
267. OR (76-265)
268. Africa/
269. South America/
270. Asia, Southeastern/
271. Pacific Islands/
272. Asia, Western/
273. Europe, eastern/
274. OR (268-273)
275. OR (76, 267, 274)

276. AND (6, 33, 59, 275)

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